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(Abstracts furnished by the authors.)

Eighty-eight new names were added to the roll of membership. The meeting of 1912 will be held at the State Historical Building in Des Moines, and will be a meeting celebrating the twenty-fifth anniversary of the organization of the academy.

Officers elected for the ensuing year are:

President—Louis Begeman, Cedar Falls.

First Vice-president—A. A. Bennett, Ames.

Second Vice-president—C. N. Kinney, Des Moines.

Secretary—L. S. Ross, Des Moines.

Treasurer—G. F. Kay, Iowa City.

Members of the Executive Committee—H. S. Conard, Crinnell; B. H. Bailey, Cedar Rapids; H. M. Kelley, Mt. Vernon.

L. S. ROSS,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 696th meeting was held on May 20, 1911, Vice-president Fischer in the chair. Three papers were read.

Experiments with Different Types of Voltmeters:

Mr. G. W. VINAL, of the Bureau of Standards.

According to Faraday's law for electrolytes the deposits of silver in different types of voltmeters should be equal when the same number of coulombs of electricity has passed through each, provided, however, that there are no secondary reactions taking place. Differences in weight and appearance have been observed, particularly between the porous cup and filter paper forms. We have endeavored to find an explanation of these effects and to push the accuracy of our measurements beyond the limits hitherto attained. A constant temperature balance room has obviated the difficulties usually encountered in weighing the platinum bowls. The current has been measured by balancing the potential drop across a standard resistance against the voltage of a Weston cell and also by the potentiometer method. The purity of the electrolyte is of great importance and the tests will be discussed elsewhere.

The Kohlrausch, or no septum form as we have used it, consists of a glass dish under the anode and a ring of glass in the surface of the liquid to prevent the slime formed during electrolysis from reaching the cathode.

The siphon voltmeter is unsatisfactory even when short siphons of large diameters are used, owing to the heating and large volume of electro-

lyte which may yield erroneous results if the electrolyte is not quite pure.

The filter paper form devised by Lord Rayleigh employs a sheet of filter paper to separate the anode and cathode. We have found the deposits in it abnormally heavy and striated in appearance, which effects are due to the filter paper not being chemically inert. Striated deposits are always heavy. We have studied the cause for striations and find two conditions to be necessary and sufficient for their production, viz., (1) the presence of reducing impurities in the electrolyte, (2) the motion of the liquid over the face of the cathode. When both of these conditions are fulfilled we may suppose any given initial distribution of points of silver which will grow in the direction of the liquid currents (usually vertical) since the crystalline structure is destroyed by colloidal deposits. In this way a crystal grows into the one above it and eventually a striation is formed. The initial spacing of the crystals and consequently the spacing of the striations is dependent on the current density.

T. W. Richards has advocated the use of a porous cup instead of filter paper to more perfectly separate the anode and cathode liquids. He gave as a reason for this substitution that a heavy complex ion could pass through the filter paper and increase the weight of deposit, but we have found that by using two or three thicknesses of filter paper the effect instead of being diminished is materially increased. The evidence of our work does not support the complex ion theory.

We have used two sizes of porous cup voltmeters and find that with electrolytes, a trifle impure, that the larger will give the heavier deposit. This phenomenon we have called the "volume effect." It is a severe test of the purity of the electrolyte. With pure electrolytes the deposits in this form are always crystalline and free from striations. The efficiency of the porous cup as a separator of the anode and cathode liquids is shown by the fact that an impure solution may be placed inside the porous cup without affecting the deposit outside or if the deposit from a contaminated solution be compared with the deposit from the same solution after filtering through a porous cup it will be noted that the striations have disappeared from the deposit.

The small porous cup voltmeter possesses many advantages over the other forms. We find from a long series of determinations two identical voltmeters of this type will agree to within one part in 100,000.

The London Conference of 1908 has declared that the electro-chemical equivalent of silver is 1.11800 mg. per coulomb, and, therefore, using this value and the international ohm and the second we find the voltage of the Weston normal cell at 20° C. to be

$$1.01827 \text{ volts, } \pm .00003.$$

The Chemistry of the Silver Voltmeter: Dr. A. S. McDANIEL, of the Bureau of Standards.

The first problem in the chemical investigation of the voltmeter was an investigation of the filter paper septum. This led to the detection of the classes of impurities in the voltmeter. The plan of investigation of the filter paper form of voltmeter was outlined. In this connection Smith's work at the National Physical Laboratory was mentioned. He added substances to the electrolyte to produce the observed striations in the deposits, and hence concluded that the striations were due to the impurities of the electrolyte. The speaker had also produced the striations experimentally. Tests were also made by the speaker to test the effect of the filter paper upon the striations. The striations produced by certain substances added to the electrolyte were described and illustrated by lantern slides.

Experiments were tried of extracting the impurities from the filter papers by soaking them in water and then drying them in the voltmeter, but it was found that the striations were still produced. It was concluded from this that oxycellulose (oxidized filter paper) caused the active principle of the striations. The degree of acidity or alkalinity has quite an effect in determining the direction of travel of the colloidal deposit or particles.

Tests were also made to account for the increase in weight of the colloidal deposit on the cathode. The effect of silk and porous pot septa in voltmeters was also investigated. The treatment of the pot before use to make it sufficiently resistant, and the action of the pot on the silver nitrate, were briefly stated.

The preparation of liquids for use in the voltmeter were described, and mention was made of the determination of the electro-chemical equivalent of silver nitrate.

The Silver Voltmeter as an International Electrical Standard: Dr. E. B. ROSA, of the Bureau of Standards.

The silver voltmeter has been used as the official standard for the measurement of electric

current since the International Electrical Congress which met in Chicago in 1893. The definitions and specifications for the fundamental electrical units recommended by the Chicago congress were adopted by the United States and several other countries in 1894. Germany, however, did not act in the matter until 1898 and then adopted somewhat different definitions and a different numerical value for the Clark standard cell which resulted in a different value of the volt. Austria and some other countries followed the example of Germany, so that for the last twelve years the ampere and volt have been slightly different in one group of countries from its value in the other countries. The International Congress at London in 1908 came to an agreement on the definitions such that there might be international uniformity, but could not fix upon the value of the standard cell for want of complete specifications of the silver voltmeter and also for want of agreement among different experimenters with the silver voltmeter. It was for the purpose of clearing up some of the mysteries in connection with this instrument, which has been the subject of more than forty scientific papers by investigators in several different countries during the last thirty years, that the work was taken up at the Bureau of Standards three years ago and has been carried on continuously ever since. One year ago an international committee representing four of the national standards laboratories met in Washington and carried out a series of investigations at the Bureau of Standards chiefly upon the silver voltmeter. As a result of these investigations a new value for the Weston cell was agreed upon after recommendation to the International Committee on Electrical Units and Standards and that value has since been adopted, so that we now have in America the same value for the volt and ampere as is used in the principal countries of the world; this value will, undoubtedly, soon become universal. There still remain some outstanding questions in connection with the silver voltmeter which must be solved before complete specifications can be agreed upon, but the investigations at the Bureau of Standards and elsewhere during the last two or three years have cleared up many of the questions which were outstanding at the time of the London conference in 1908.

(The first and last of the above abstracts are by the authors of the papers.)

R. L. FARIS,
Secretary